Rule-Following and Human Operant Responding: Conceptual and Methodological Considerations

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A conceptual analysis of rule-governed behavior, emphasizing pliance and tracking as functional classes of rule-following, is provided and related to previous methodological strategies in human operant research. A novel strategy, which utilizes a microcomputer to reinforce correspondences between subject guesses and responding, is proposed for the study of rule-following. Results from a preliminary demonstration of the procedures are reported briefly, and possible applications to the further analysis of rule-following are discussed.

Responding of human subjects on operant schedules presumably is multiply determined. In addition to being shaped directly by programmed contingencies, human operant responding may constitute instances of rule-governed behavior. The last decade in particular has seen increased attention given to the potential role of verbal control in human operant behavior (e.g., Baron & Galizio, 1983; Harzem, Lowe, & Bagshaw, 1978; Lowe, 1979, 1983). Whether or not a particular example of human operant responding is contingency shaped and/or rule-governed cannot be determined a priori but must be based on a functional analysis of the behavior in question.

Because of the fine-grained analysis of behavior which operant schedules permit, they provide an especially useful preparation for the study of rule following. Several strategies have been employed in this undertaking. These have included the systematic presentation and withdrawal of instructions which may or may not correspond to programmed contingencies (e.g., Galizio, 1979, Hayes, Brownstein, Zettle, Rosenfarb, Korn, 1986), shaping or instructing subjects' verbal behavior (Catania, Matthews, & Shimoff, 1982; Matthews, Catania, & Shimoff, 1985), the analysis of postsession verbal reports (Shimoff, 1986), and performance comparisons of preverbal and verbal children on operant schedules (Bentall, Lowe, & Beasty, 1985; Lowe, Beasty, & Bentall, 1983). The purpose of this paper is to review earlier work in the context of a specific conceptualization of rule-governed behavior. An additional strategy for the analysis of verbal control in human operant responding will be described and results from a preliminary study will be discussed.

FUNCTIONAL CLASSES OF RULE-FOLLOWING

For present purposes at least two distinct functional classes of rule-governed behavior, pliance and tracking, may be considered (Zettle & Hayes, 1982). Additional classes may exist but are of less relevance to this overview (see Hayes, in press; Zettle & Hayes, 1982 for further discussion).

Pliance

One type of rule-following has been termed *pliance* (Zettle & Hayes, 1982). Pliance is rule-governed behavior under the control of socially mediated consequences for a correspondence between the rule and relevant behavior. The rule itself is termed a *ply*. For pliance to be reinforced members of a verbal-social community must have access to the relevant ply and be capable of monitoring the corresponding behavior and controlling reinforcing consequences. Reinforcement for pliance is arbitrary insofar as it is controlled by socially-mediated reinforcement for a correspondence between the ply and behavior. For this reason, pliance as a class of rule-following may occur even when natural (i.e., nonarbitrary) contingencies surrounding the

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behavior are aversive or punishing. Indeed, pliance may show the type of insensitivity to natural contingencies which has been regarded by some as a defining property of instructional control (Shimoff, Catania, & Matthews, 1981).

Following orders or commands may be viewed as instances of pliance. Correspondence training between saying and doing (Risley & Hart, 1968; Rogers-Warren & Baer, 1976) similarly may be conceptualized, at least in part, as a means of establishing a type of rule-following in which the ply and corresponding behavior are emitted by the same individual. Once pliance is established as a response class, rule-following may show sensitivity to a wide array of social variables. For example, coping self-statements utilized in cognitive-behavior modification procedures (Meichenbaum, 1977) have been shown to control therapeutic responding when issued in a public context (i.e., therapist has access to the coping instructions given) but to be ineffective within a private context (i.e., subjects are led to believe that the therapist does not have access to the instructions) (Hayes & Wolf, 1984; Rosenfarb & Hayes, 1984; Zettle & Hayes, 1983). Similar effects also have been noted with goal-setting and self-reinforcement procedures in which subjects formulate their own rules or instructions (Hayes, Rosenfarb, Wulfert, Munt, Korn, & Zettle, 1985).

Such findings would appear to have direct implications for human operant research. Changes to schedule-typical responding which subjects show upon the withdrawal of instructions suggest that following such rules may be interpreted as an instance of pliance (Hayes et al., 1986). Similarly, Hayes et al. have suggested that differential effects of shaped versus experimenter-instructed rules (Catania et al., 1982) may result from the social context in which shaping occurs. That is, interactions between experimenter and subjects necessary to shape particular guesses may be the same conditions which enable such verbal behavior to function as plys. Further research (Matthews et al., 1985) suggests that shaped guesses which specify particular ways of responding (e.g., "press fast") are more likely to exert such control than those merely tacting the relevant contingencies (e.g., "the button works after a random number of presses").

The above analysis suggests that social variables may exert considerable control over rule-following in human operant research. Such sources of control conceivably could be maximized, for example, by having subjects publicly state their guesses or rules and by increasing experimenter surveillance of responding. Alternatively, variables controlling pliance might be minimized by having subjects make guesses and receive instructions privately (i.e., lead subjects to believe that the guesses they make and instructions received cannot be known by the experimenter) and by minimizing (at least from the subjects' perspective) observations of their responding.

Tracking

A second type of rule-following which may affect human operant responding is *tracking*. Tracking is rule-governed behavior "under the control of the apparent correspondence between the rule and the way the world is arranged" (Zettle & Hayes, 1982, p. 81). The rule itself is termed a *track*. While reinforcement for pliance is socially-mediated and arbitrary, reinforcement for tracking results from natural contingencies surrounding relevant behavior. Unlike pliance, tracking is not dependent upon the ability of members of a verbal-social community to discriminate the presentation of a rule as well as monitor and reinforce behavior in correspondence with the rule. For this reason, tracking may occur in a completely private context as when individuals consult manuals or written instructions in guiding their behavior.

Following instructions, directions, and advice of others (e.g., "The best way to stop a car on ice is to pump the brakes") may be viewed as instances of tracking. Like pliance, tracking may be conceptualized as a functional class of rule-following. With an appropriate reinforcement history, tracking may come under the control of rules of particular forms (e.g., descriptions of contingencies) as well as certain rule-givers. It is important to note that tracking also may occur under the control of self-generated rules (Skinner, 1969, chap. 6). Once individuals have learned to tact their own behavior and the variables of which it is a function, they may be able to respond more effectively and/or efficiently by following such rules as tracks. This analysis has been cited by Lowe and his colleagues (Bentall et al., 1985; Lowe et al., 1983) in accounting for differential response patterns of preverbal and verbal children on operant schedules. Only preverbal infants show the same type of schedule-typical behavior (e.g., fixed interval scallops) as displayed by nonhuman organisms. Older children exhibit response patterns typical of adult subjects as well as verbal behavior which generally corresponds with their behavior.

The inherent difficulties in relying on postsession verbal reports as evidence of tracking in human operant responding have been discussed at length by Shimoff (1986) and only will be reiterated briefly here. Pertaining to the current analysis, it is possible that verbal behavior reported at postsession may have functioned as tracks during the session itself. In the absence of a functional analysis, however, it is equally plausible that this verbal behavior may follow rather than precede and control responding. In doing so, such verbal behavior represents tacts under the control of schedule performance. Another possibility is that verbal behavior obtained in postsession reports is occasioned more directly by the experimenter's inquiry. Because of social contingencies for a correspondence between doing and saying, subjects' verbal behavior under such conditions could be viewed as impure tacts at least partially under the control of experimental demand characteristics.

A METHODOLOGICAL PROPOSAL

Whatever subjects may say to themselves while responding on operant schedules can only affect schedule performance by participating in a controlling rather than causal relationship. As detailed by Skinner (1953, chap. 15) in his analysis of self-control, one response may enter into a controlling relationship with another, but only when external contingencies are present which support a behavior-behavior relationship. In everyday experience guesses, rules, instructions, and other types of self-talk control our actions (to the extent that they do so) because such verbal control allows us to respond more effectively and efficiently. When faced with a problematic situation, some of us are likely to formulate hypotheses or rules and test them out. If they prove useful, we are more likely to formulate rules and follow them on future occasions.

These observations as well as the conceptualization of tracking presented suggests a methodology for studying rule-following in the human operant laboratory. With the assistance of a microcomputer it is possible to match subjects' guesses about operant schedules with actual programmed contingencies. In such an arrangement, the consequence which reinforces tracking presumably is "being right." The effect expected may be similar to that which might be seen in someone who successfully uses a formula in playing the horses. An interesting question is what occurs when the individual's guesses are no longer correct? Stated somewhat differently, what will occur when the natural contingencies which have supported a controlling relationship between self-formulated tracks and behavior are weakened or no longer in effect? Further, how will an individual's behavior under such conditions compare with another whose behavior has not been guided by rules but has received the same pattern of reinforcement?

These issues were addressed in a study described in the next section. The research was designed to explore the utility of our analysis of tracking. One group of subjects undertook a computerized task in which their guesses about correct responding initiated programmed contingencies that matched their guesses. A second group served in a control condition in which movement of the marker in the task and receipt of points were yoked with patterns occurring for experimental subjects. Extinction was then implemented in both groups. During the preextinction phase, subjects in the experimental condition were exposed to contingencies designed to reinforce a controlling relationship between their guesses and related responding. Subjects in the yoked condition, by contrast, did not have their tracking reinforced in any systematic fashion. Based on the analysis of tracking presented earlier, it was predicted that subjects in the experimental condition, for whom tracking was reinforced systematically in the preextinction phase, would show significantly greater resistance to extinction. To the extent that results are obtained consistent with this prediction, the validity of our analysis of rule-following receives preliminary support.

RELATED RESEARCH

Subjects

Sixteen volunteers recruited from an introductory psychology class served as subjects. Half were assigned randomly to an experimental condition with the remainder serving as yoked controls.

Apparatus

An Apple II microcomputer controlled all schedules and recorded all data. Subjects sat alone in a small room in front of the computer screen. A shroud over the keyboard restricted access to all but the space bar and one key to each of its sides.

Procedure

All subjects initially were presented general instructions by the experimenter which in part read:

> The purpose of this study is to understand further various strategies individuals use in problem solving. This is not a psychological test; rather, our interest is in gaining further insight into how people learn to solve problems. The task you will be presented involves learning what is necessary to move a marker across the computer screen. The marker may be moved by pressing the space bar in particular ways. You will receive one point each time the marker is moved completely across the screen from left to right. You also will receive a message on the screen indicating the receipt of each point. Each point will entitle you to one ticket in a drawing for a $20 prize that will be held at the end of the study.

After collecting watches, notebooks, and other distracting materials, the session began. In order to minimize contamination by social contingencies all further instructions were presented on the computer screen.

The task itself involved movement of a marker through a row of four boxes displayed on the computer screen. A point was awarded for each movement of the marker out of the extreme right-hand box. A message then appeared on the screen indicating that a point had been earned and informing subjects of their cumulative totals.

Movement of the marker was programmed according to three different schedules. All subjects initially were presented with a random time (RT) schedule for 2.5 min. Movement of the marker occurred after the passage of a randomly selected interval from 10-40 seconds and was not controlled in any way by pressing the space bar. After 2.5 min exposure to RT, the following message appeared on the screen to subjects in the experimental condition: "What do you feel is the controlling factor affecting movement of the marker?" Subjects were presented with two options, either "the number of presses you make" or "the amount of time between successive presses." Subjects were instructed to make their choice by pressing the appropriate key to either side of the space bar. If subjects indicated "number of presses," a fixed ratio (FR 18) schedule was initiated and if "amount of time," a differential-reinforcement-of-low-rate (DRL 2-s) schedule was implemented for the next 2.5 min. After 2.5 min of either FR or DRL all subjects received a message on the screen informing them of the termination of that task and the presentation of a new one. This message was followed by another 2.5 min of RT, another request for sujects in the experimental condition to indicate their guesses, and depending on their selection, another 2.5 min of FR or DRL. This sequence continued for exactly 32 min at which time extinction was implemented for 15 min. At the end of the extinction phase all subjects completed a postsession questionnaire to provide a manipulation check.

Each subject in the control group was yoked with another in the experimental condition. During the preextinction phase for each experimental subject, the computer recorded the precise movement of the marker and receipt of points in time. This information was stored and used in presenting the exact temporal sequence of marker movements and point earnings to yoked subjects as experienced by their experimental counterparts. During periods in which experimental subjects were asked to make guesses yoked subjects received a message informing them of a short pause before the next task.

RESULTS

Number of responses for subject pairs during preextinction and extinction phases are presented in Table 1. More preextinction responses were displayed by subjects in the yoked control condition for seven of eight pairs. A randomization test (Siegel, 1956)

Table 1

Number of Responses in Preextinction and Extinction and Response Ratios for Subject Pairs

	Condition					
	Experimental			Yoked Control		
Pair	Preextinction	Extinction	Ratio[a]	Preextinction	Extinction	Ratio
1	216	115	.532	324	97	.299
2	676	325	.480	1412	684	.484
3	516	292	.566	1457	713	.489
4	584	550	.942	1219	239	.196
5	1353	611	.456	3882	1598	.412
6	928	497	.536	2123	431	.203
7	756	517	.684	275	94	.342
8	441	249	.565	770	220	.286

[a]Values derived by dividing number of extinction responses by number of preextinction responses.

indicated significantly more responses for control subjects (p = .02). Because yoked subjects received the same number of points as their experimental counterparts, higher rates of responding consequently were reinforced during preextinction for control subjects. Accordingly, higher rates of responding during extinction would be expected for these subjects. This, however, was not the case as higher rates of responding for yoked subjects were noted in only three of eight pairs.

The central prediction which this study sought to evaluate was that subjects in the experimental condition, because of systematic reinforcement of tracking, would show greater resistance to extinction. A ratio of number of extinction responses divided by number of preextinction responses was calculated for each subject as an index of resistance to extinction. These ratios are displayed in Table 1, with higher values indicating greater resistance to extinction. Expected results were obtained as higher ratios were noted for experimental subjects in seven of eight pairs. A randomization test also indicated a statistically significant difference in response ratios between the two conditions (p = .008).

Postsession reports. At postsession all subjects were asked what they believed was required to move the marker. Five of the yoked control subjects indicated that number or pattern of presses on the space bar was necessary. The remaining three subjects reported no knowledge of what was required. No differences were found in comparing these two subgroups on number of responses in preextinction, extinction, or in resistance to extinction ratios.

Half of the experimental subjects indicated that movement of the marker depended upon time alone or time between bar presses. The other half reported number of responses as well as a temporal requirement. A comparison of these two subgroups revealed no differences in number of responses in preextinction and extinction or in resistance to extinction ratios. Unfortunately, due to the limited capacity of the microcomputer it was not possible to determine whether postsession responses corresponded with guesses during the preextinction phase.

SUMMARY AND CONCLUSIONS

The overall findings appear consistent with our conceptual analysis of tracking as a functional class of rule-following. Because reinforcement in the yoked condition was more intermittent and associated with significantly higher rates of preextinction responding, greater resistance to extinction should have been evidenced by control subjects. The exact opposite occurred, however, as subjects in the experimental condition, whose guesses were always correct during preextinction, demonstrated greater resistance to extinction. Quite likely yoked subjects also were making guesses and formulating hypotheses about schedule requirements. Such guesses though were not reinforced systematically by being correct and thus were not expected to function as tracks.

Apparently the behavior of experimental subjects was controlled not only by programmed contingencies but also by nonarbitrary reinforcement for responding in correspondence with their guesses. Due to the exploratory nature of this study and lack of appropriate control manipulations, other interpretations may be proposed. It might be argued, for example, that the process of making explicit guesses, regardless of whether or not they proved to be "correct," accounted for differences in resistance to extinction. Is the mere formulation of a rule sufficient or is a history of correspondence between that rule and behavioral outcomes also necessary for a resistance to extinction effect? This issue could be evaluated by ensuring that guesses for some subjects are never correct. A more comprehensive analysis could evaluate the impact of a wider range of reinforcement probabilities (e.g., 100%, 75%, 50%, 25%, 0%) on tracking ranging from continuous to intermittent. In the present study ambiguity was created by periodic implementation of an RT schedule. Another strategy to analyze the degree of control exerted by mere guessing would be to have subjects make repeated guesses while continuously presented with an RT schedule.

Consistent with the pliance versus tracking distinction, an attempt was made to minimize social contingencies affecting rule-following. Because variables controlling pliance can be fairly subtle, the possibility that the behavior of experimental subjects was at least partially affected by social variables cannot be ruled out. This possibility could be evaluated further by having some subjects make their guesses under conditions of social surveillance (e.g., have the experimenter present while subjects make guesses or have subjects report their guesses to the experimenter). Any differences noted between such a manipulation and the experimental condition in the present study would suggest dissimilar types of rule-following.

Relative to recent differential effects associated with performance and contingency descriptions (Matthews et al., 1985), it should be noted that guesses subjects made resembled the latter more than the former. Specifically subjects were asked to indicate whether they believed movement of the marker was dependent on "the number of presses you make" or "the amount of time between successive presses." It might be instructive, therefore, to repeat the procedure with subjects asked to select among options which are more descriptive of performance requirements (e.g., "press fast" or "press slowly") than the actual contingencies.

Despite being expected, the findings reported should be viewed as tentative and preliminary in nature. In our view, the results may be regarded more valuably as an initial demonstration of a methodological strategy for studying rule-following in human operant preparations, than as strong support for our analysis of tracking. The continued use of microcomputers in the manner employed in this investigation appears to have considerable promise in not only further clarifying the present findings, but also in analyzing rule-governed behavior more generally. Indeed, its applicability may be limited only by the ingenuity and computer programming skills of researchers. Whether our optimism in this regard is warranted or not, of course, must await further application of the procedure. However, given the complexity of verbal control and its importance in predicting and controlling human behavior, any methodological strategy which may permit a further understanding of rule-following would appear to merit further exploration.

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